Sample: CDS130 Mid-term exam **KEY**

- Be sure your exam booklet has 9 pages.
- Write your name at the top of each page.
- This is a closed book exam.
- You may not use a calculator.
- You may not use MATLAB during exam.
- Absolutely no interaction between students is allowed.
- Each question is worth 5 points. Partial credit may be awarded ONLY if work is shown.
- Duration for this exam: 60 minutes.

Q1. $(25)_{10}=(?)_2$

A) 100110

B) 10011

C) 11001

D) 110010

Answer: C

$$25 = 1\,x\,16 + 1\,x\,8 + 0\,x\,4 + 0\,x\,2 + 1\,x\,1 \equiv (1\,1\,0\,0\,1)_2$$

Q2. The binary system

A) is a positional notation based on the powers of 2

B) typically uses more digits than the decimal system to represent the same number

C)all of the above

D) None of the above

Answer: C

Q3 To avoid overflow problems, the maximum non-negative integer that can be represented with 5 bits is:

A) 16
B) 31
C) 63
D) 64

Answer: B

The largest non-negative number can be represented with N bits is: $2^N - 1$. Here, $N=5$

Q4 The minimum number of bits needed for an integer word to represent all integers between 0 and 1024 is:
A) 8
B) 9
C) 10
D) 11

Answer: D
The largest integer represented by 10 bits is 1023, and the largest integer resprened by 11 bits is 2047. You need 11 bits to represent all integers between 0 and 1024.

Q5 How many zeroes are in the binary representation of 2^{20}?
A) 18
B) 19
C) 21
D) 20

Answer: D
$2^{20} = 1\,x\,2^{20} + 0\,x\,2^{19} + 0\,x\,2^{18} + 0\,x\,2^{17} + ... + 0\,x\,2^{1} + 0\,x\,2^{0}$ (20 0s in the binary representation).

Q6.If an arbitrary 8 bit binary number is multiplied by 4, what is the maximum number of bits required to write that product as a binary number?
A) 9
B) 10
C) 11
C) 12
D) 16

Answer: B
Method 1: The largest number represented by 8 bits is 255. If this number is multiplied by 8, the product is 1020. You need 10 bits to store this number.

Method 2: if an arbitrary number is multiplied by 2, the bits are shifted to its left by one position. For example, if $(11111111)_2$ is multiplied by 2, the binary number becomes: $(111111110)_2$.
Likewise, If the number is multiplied by 4, the binary number shits to its left by two bit positions, and becomes $(1111111100)_2$. You need 10 bits to store the number.

Q7. How many unique combinations of 1s and 0s are possible with 12 bits?
A) 4096
B) 4095
C) 2048
D) 2047
E) None of the above

Answer: A
The number of unique combinations of 1s and 0s is 2^{12} . (Remember: $2^{10}=1024$)

Q8. Convert 11110111_2 into hexadecimal.
A) F7
B) 157
C) 3313
D) B7
E) None of the above

Answer: A
To convert binary numbers to hexadecimal, following the next three steps:
1). Divide the binary into groups of four bits, starting from the left.
For example: $11110111_2 = (\underline{1111}\ \underline{0111})_2$
2). Convert each group into a hexadecimal number, $1111_2=F_{16}$, $1110_2=E_{16}$, ... $0001_2=1_{16}$
3). Group the converted hexadecimal digits into a hexadecimal number:
$11110111_2 = (\underline{1111}\ \underline{0111})_2 = (F7)_{16}$

Q9. Here is a two's complement representation of an decimal integer: 0011 1001
Form the 8-bit negative equivalent of this binary integer use the two's complement method:
A) 1100 0110
B) 1011 1001
C) 1100 1110
D) 1100 0111
E) None of the above

Answer: D
To find the negation of the binary number with the 2's complement notation, the trick is:
(1) Bitwise NOT: $0011\,1001 \rightarrow 1100\,0110$
(2) Add 1: $1100\,0110 + 1 = 1100\,0111$

Remember: In two's complement notation, the most significant bit is a negative number (-2^N , N is the number of bits), and the rest of the bits represent positive number.

Q10.What is the 8-bit result of adding the following three 8-bit numbers together?

0 1 1 0 0 1 1 1
0 1 1 1 0 0 0 1
0 1 1 1 1 1 1 1
= ________________________________

Answer:

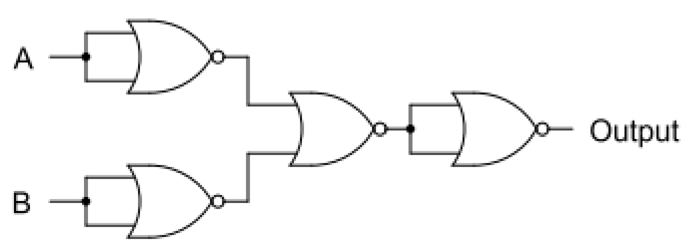
  0 1 1 0 0 1 1 1
\+ 0 1 1 1 0 0 0 1
____
  1 1 0 1 1 0 0 0

  1 1 0 1 1 0 0 0
\+ 0 1 1 1 1 1 1 1
____
1 0 1 0 1 0 1 1 1

The answer is: 1 0 1 0 1 0 1 1 1.

Assuming an unsigned representation, is there overflow? (circle one) yes no [answer: yes].

Q11. What one logic gate is equivalent to the logic circuit shown below? Draw the logic gate.



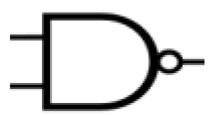
Answer:
Truth table for the NOR gate is:

A	B	NOR
1	1	0
1	0	0
0	1	0
0	0	1

The logic table for the provided logic gate is:

A	B	OUT
1	1	0
1	0	1
0	1	1
0	0	1

This corresponds to an NAND gate.



Q12. Water flows into one, both, or none of the two white tubes at the top. What logic gate does it produce?

A) AND
B) OR
C) NAND
D) NOR
E) XOR

Answer: B
Water flows from both tubes, (A=1, B=1), the output is 1.
Water flows from one tube, and the other tube has no water flow (A=1, B =0), the output is 1
No water flows in either tube, (A=0, B = 0), the output is 0.
This is equivalent to an OR logic gate.

Q13. What is the output of the following MATLAB code

```
clear;
A(1, 3) = 2;
A(1, 5) = 3;
A(5)
```

A) 3 3 3 3 3
B) 2 2 2 3 3
C) 0 0 2 0 3
D) 0 0 0 0 3
E) None of the above

Answer: C

(1) After executing A(1, 3) = 2
A =
0 0 2
(A is now a row vector, and this command is equivalent to: A = [0, 0, 2]).

(2) After executing A(1,5) = 3
A =
0 0 2 0 3

Q14. What is the output of the following MATLAB code:

```
A = [1.2,3.4,5.6; 2.1,5.3,4.6];
B = [1:3; 2:4];
A+B
```

Answer: ans =

(1) After executing A = [1.2,3.4,5.6; 2.1,5.3,4.6]

```
A =
    1.2  3.4  5.6
    2.1  5.3  5.6
```

(Note: this creates a 3x2 matrix with 2 rows, 3 columns)

(2) After executing B=[1:3; 2:4]

```
B =
    1   2   3
    2   3   4
```

Note: this is a colon notation for matrix creation.

(3) Add the two matrix A + B:

```
A +B
ans =
    3.2   5.4   8.6
    4.1   8.4   8.6
```

Do you know sum(A+B)?

```
sum(A+B)
ans =
    7.3    13.8    17.2
```

Q15. What is the output after executing the following MATLAB code:

```
clear;
mat1(1,5) = 0.0;
mat2(1,5) = 0.0;
mat3(1,5) = 0.0;

for i = [1:3]
 mat1(i) = i*i;
 mat2(i) = 1.0/i;
 mat3(i) = mat1(i) + mat2(i);
end
mat3
```

Answer:
1:3 is equivalent to [1, 2, 3].

During the first iteration i=1
mat1(1) = 1
mat2(1) = 1
mat3(1) = 2

(Note: mat1, mat2, mat3 are names for three vectors).

During the second iteration i= 2

mat1(2) = 4
mat2(2) = 0.5
mat3(2) = 4.5

During the third iteration i=3

mat1(3) = 9
mat2(3) = 0.3333
mat3(3) = 9.3333

The final answer for mat3

ans =

4 4.5 9.3333

Q16. Use a single command to create a row vector (assign it to a variable named B) with 9 elements such that

B =

1.1 1.2 1.3 1.4 1.5 1.4 1.3 1.2 1.1

Do not type the vector explicitly.

Answer:

B = [1.1: 0.1 : 1.5, 1.4:-0.1: 1.1]